Review Draft

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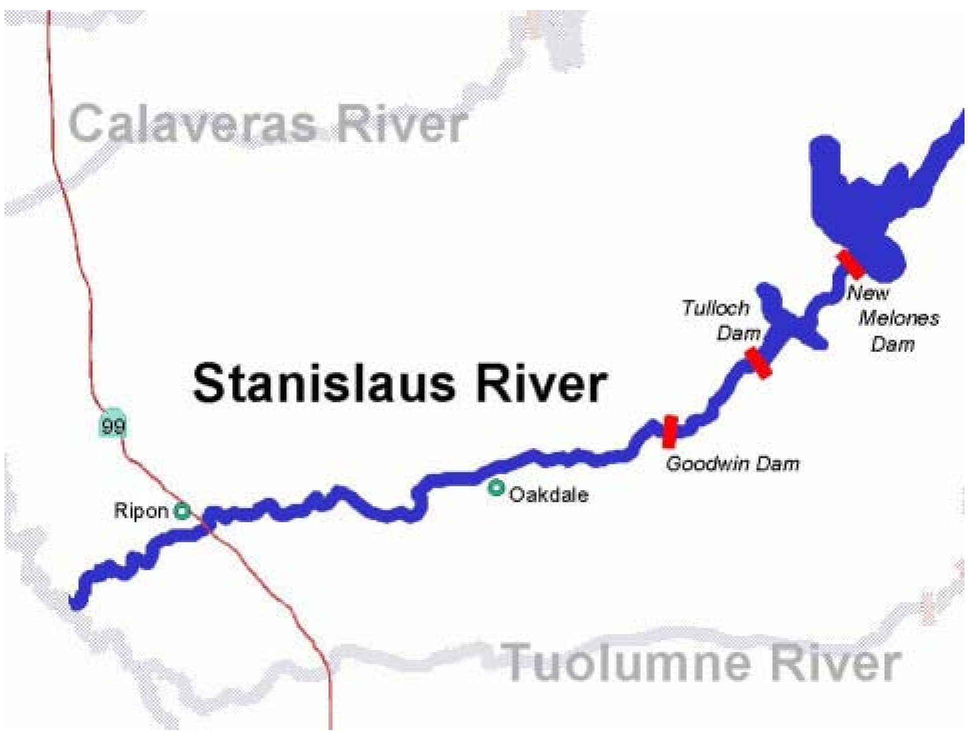
A Consensus-Based Plan to Direct the
Long-Term Implementation of Prioritized Restoration and Research
in the Stanislaus River below Goodwin Dam



The Stanislaus River Fish Group

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A Plan To Restore Anadromous Fish Habitat In The Lower Stanislaus River

A Consensus-Based Plan to Direct the Long-Term Implementation of Prioritized Restoration and Research in the Stanislaus River below Goodwin Dam

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Participating Agencies/Organizations Include:

U.S. Fish and Wildlife Service, California Department of Fish and Game, California Department of Water Resources, NOAA Fisheries, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and other organizations conducting research in the Stanislaus River.

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Companion Report:

SRFG. 2003. A Summary of Fisheries Research in the Lower Stanislaus River. Draft report produced for the U.S. Fish and Wildlife Service's Anadromous Fish Restoration Program. Stockton, CA.

LIST OF ACRONYMS AND ABBREVIATIONS

AFRP	Anadromous Fish Restoration Program
BOD	biological oxygen demand
CALFED	CALFED Bay Delta Authority
CDFG	California Department of Fish and Game
cfs	cubic-feet-per-second
CMC	Carl Mesick Consultants
COD	chemical oxygen demand
CRRF	California Rivers Restoration Fund
CVP	Central Valley Project pumping facilities at Tracy
DO	dissolved oxygen
DWR	California Department of Water Resources
EIS/EIR	Environmental Impact Statement/Environmental Impact Report
ESA	federal Endangered Species Act
NMIPO	New Melones Interim Plan of Operation
NOAA Fisheries	National Marine Fisheries Service
OID	Oakdale Irrigation District
Ppm	parts per million
SEWD	Stockton East Water District
SJRA	San Joaquin River Agreement
SPCA	S.P. Cramer & Associates, Inc.
SSJID	South San Joaquin Irrigation District
SRBS	Stanislaus River Basin Stakeholders
SWP	State Water Project pumping facilities in the Delta
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TDS	total dissolved solids
TMDL	total maximum daily load
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VAMP	Vernalis Adaptive Management Program
WQCP	Water Quality Control Plan

1 INTRODUCTION

The Stanislaus River Fish Group is developing this restoration plan in an adaptive management context to help guide fisheries research and the restoration of ecosystem processes and habitats in the Stanislaus River downstream from Goodwin Dam. Our goal is to increase the abundance of at-risk anadromous fish species, including Chinook salmon (formally King salmon; *Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*). The purpose of this plan is twofold: (1) to provide guidance for all interested parties on the design, implementation, and monitoring of proposed restoration projects and research programs in the lower Stanislaus River; and (2) coordinate restoration and research activities between the resource agencies, stakeholders, and the local citizenry.

The plan is envisioned as a "living document" that will need to be periodically updated as we learn from ongoing and future restoration projects throughout the Central Valley. As the plan is developed and updated, it will be posted on websites created by S.P. Cramer & Associates, the California Rivers Restoration Fund, and the Anadromous Fish Restoration Program to encourage comments from stakeholders and the local citizens. It is anticipated that additional funding will be provided to periodically update the plan.

1.1 BACKGROUND

1.1.1 Stanislaus River Fish Group

The Stanislaus River Fish Group consists of representatives of the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), California Department of Water Resources (DWR), National Marine Fisheries Service (NOAA Fisheries), U.S. Army Corps of Engineers (USACE), U.S. Bureau of Reclamation (USBR), California Rivers Restoration Fund (CRRF), and other organizations conducting research in the Stanislaus River: including S.P. Cramer and Associates, Inc. (SPCA), Carl Mesick Consultants (CMC), Fisheries Foundation, and the University of California at Berkeley. The Stanislaus River Fish Group has been meeting to exchange information and discuss fishery management issues since 1996.

1.1.2 Purpose and Need for Restoration Plan

Although other fishery restoration plans have been written for the lower Stanislaus River over the past decade, few restoration actions or studies have been implemented to date compared to the Tuolumne and Merced rivers and other large rivers in the Central Valley. The total amount of funding allocated for restoration and research on the lower Stanislaus River is about \$1,070,000, whereas \$18,700,000 and \$8,720,000 have been allocated for the Tuolumne and Merced rivers respectively (www.delta.dfg.ca.gov/afrp). One reason for the lack on progress on the lower Stanislaus River is the lack of a local-level consensus-based plan. The previous restoration plans that were developed for Central Valley Rivers, including the lower Stanislaus River, were all produced by government resource agencies:

- Department of Fish and Game's 1993 Restoring Central Valley Streams: A Plan for Action;
- U.S. Fish and Wildlife Service's 2001 Final Restoration Plan for the Anadromous Fish Restoration Program;

- U.S. Fish and Wildlife Service's 1998 Central Valley Project Improvement Act Tributary Production Enhancement Report; and
- CALFED's 2000 Ecosystem Restoration Program Plan.

Unlike the previous plans, this restoration plan is the first to be developed specifically for the lower Stanislaus River with input from all stakeholders and the local citizenry. Both the Anadromous Fish Restoration Program (AFRP) and the CALFED Bay Delta Authority (CALFED) emphasize the need to work with all stakeholders and the local citizenry to develop restoration plans in an adaptive management context to restore processes and habitats that benefit at-risk fish species, including Chinook salmon and steelhead in the Central Valley.

Another reason for the lack of progress on restoring the lower Stanislaus River is that only the CALFED plan had undergone an external review by restoration experts. It is anticipated that additional funding will be provided for an external review of this plan.

A third reason is that none of the previous plans provided guidance as to the design, implementation and monitoring of potential projects. Although there has been agreement as to the type of action needed, there has been disagreement regarding the proposed methods or design of restoration projects. This plan will provide consensus-based recommendations for the design, implementation, and monitoring for all actions designated as a high-priority.

1.1.3 Funding and Preparation

The AFRP has provided partial funding for CMC, SPCA, and CRRF to produce the initial plan with the input of all stakeholders and the local citizenry. CMC and CRRF have donated a substantial amount of time and materials toward the completion of this plan.

1.2 SCOPE OF RESTORATION PLAN

The Stanislaus River is one of three major tributaries to the San Joaquin River (Figure 1). Its watershed is about 1,100 square-miles in which most of the precipitation falls between November and April near the headwaters (Kondolf and others 2001). The average unimpaired basin runoff is approximately 1,200 thousand acre-feet (TAF), which is approximately 21% of the total for the San Joaquin River basin. In comparison, the unimpaired average runoff of the Tuolumne River at La Grange Dam and the upper San Joaquin River at Friant Dam is approximately 33.2% and 30.2% of the basin total, respectively.

1.2.1 Lower Stanislaus River

This plan focuses on the 58.3-mile reach of the Stanislaus River between Goodwin Dam and the confluence with the San Joaquin River (Figure 1). Currently, anadromous fish cannot migrate upstream of Goodwin Dam.

Figure 1. Lower Stanislaus River between New Melones Reservoir and the confluence with the San Joaquin River. The green dots show the approximate locations of the Stanislaus River Parks that are owned and managed by the U.S. Army Corps of Engineers. These recreation areas include Two-Mile Bar (TMB), Knights Ferry (KF), Lovers Leap (LL), Horseshoe Road (HR), Honolulu Bar (HB), Buttonbush (BB), Orange Blossom (OB), Valley Oak (VO), Oakdale Recreational Park (OR), Riverbank (RB), Jacob Meyers (JM), McHenry Avenue (MHA), Ripon (RP), Mohler Road (MR), and River's End (RE). The location of Caswell Memorial State Park is also shown.

1.2.2 Anadromous Fish Species of Primary Concern

This plan focuses on habitat restoration for two species of anadromous fish: Chinook salmon and steelhead. Anadromous fish spend most of their lives in the sea and migrate as adults to spawn in fresh water. Steelhead and spring-run Chinook salmon in the lower Stanislaus River and elsewhere in the Central Valley are listed as threatened under the federal Endangered Species Act of 1973. Spring-run Chinook salmon are also listed under the California Endangered Species Act. Fall-run Chinook salmon in the Stanislaus River and elsewhere in the Central Valley are candidates for listing under the federal Endangered Species Act (ESA).

Under section 4(d) of the ESA, government agencies or private entities are prohibited from taking steelhead except under approved programs. The term "take" is defined under the ESA as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct (ESA section 3[19]). It is also illegal to possess, sell, deliver, carry, transport, or ship any species that has been taken illegally (ESA section 9[a][1]). The term "harass" is defined as an intentional or negligent act that creates the likelihood of injuring wildlife by interfering with it to such an extent as to significantly disrupt normal behavior patterns such as breeding, feeding, or sheltering (50 CRF 17.3). The term "harm" refers to an act that actually kills or injures a protected species (50 CRF 222.102 (64FR 60727)). Harm can arise from a significant habitat modification or degradation where it actually kills or injures protected species by significantly impairing essential behavior patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. NOAA Fisheries (2000) has provided criteria in the 4(d) rule for the following programs that if followed, provides assurance that the program activities will not violate the take prohibitions and will not be subject to enforcement actions:

- Scientific research conducted by, supervised by, or coordinated with state fishery agencies
- Fish harvest activities
- Artificial propagation programs
- Habitat restoration based on watershed plans
- Properly screened water diversions
- Routine road maintenance
- Municipal, residential, commercial, and industrial development and redevelopment

Sections 7 and 10 of the ESA provide other mechanisms by which NOAA Fisheries may permit take when it is the incidental result of carrying out an otherwise lawful activity (NOAA Fisheries 2000). Section 7 applies to projects authorized, funded or carried out by Federal agencies, whereas Section 10 applies to Non Federal applicants. Under Section 7, the Federal agencies must consult with NOAA Fisheries to ensure that they will not jeopardize the continued existence of the listed species or destroy or adversely modify their critical habitat. Under Section 10, applicants for an *Incidental Take Permit* must submit a *Habitat Conservation Plan* that identifies the (a) impacts expected from any take associated with activities covered by the plan; and (b) the steps that will be taken to monitor, minimize, and mitigate those impacts.

Other anadromous fish species that occur in the lower Stanislaus River include striped bass (*Morone saxatilis*), American shad (*Alosa sapidissima*), Pacific lamprey (*Lampetra tridentata*) and river lamprey (*L. ayresi*). Striped bass and American shad were introduced into the Sacramento-San Joaquin basin in the late 1880s. Neither is considered to be threatened. Numerous juvenile and a few adult Pacific lamprey and a few juvenile river lamprey are caught by SPCA in their screw traps in the lower Stanislaus River each year. Petitions have been filed to list both the Pacific and river lampreys as threatened or endangered. In April 2003, the USFWS indicated that there are insufficient funds to begin formal consideration until later this year.

Historical Accounts

Historically, spring-run, fall-run and possibly late fall-run Chinook salmon (Yoshiyama and others 1996) and steelhead trout (Yoshiyama and others 1998) occurred in the Stanislaus River. The California Department of Fish and Game (CDFG) speculated that historically the spring-run was the primary salmon run in the Stanislaus River, but after Goodwin Dam blocked upstream migration sometime between 1913 and 1929, the fall-run population became dominant (*in* Yoshiyama and others 1996). Historical records on late fall-run Chinook salmon and steelhead trout in the San Joaquin tributaries are sparse (Yoshiyama and others 1998).

Goodwin Dam, which was completed in 1913, is approximately 58.3 miles upstream from the confluence of the Stanislaus River with the San Joaquin River. Clark (1929) reported that there was a fish ladder at Goodwin Dam and that anadromous fish used to spawn upstream of the dam. However, Hatton (*in* Yoshiyama and others 1996) stated in 1940 that the Goodwin Dam ladder was "seldom passable" and that the fluctuating water level caused by hydroelectric operations above the dam made it "very nearly an impassable barrier". Hydroelectric operations that made the ladder ineffective may have begun with the completion of the original Melones Dam in 1926. Fry (1961) also reported that Goodwin Dam was a barrier to migration after CDFG began its salmon escapement surveys in 1940.

Salmon and steelhead were abundant in the Merced and Tuolumne rivers and presumably the Stanislaus River as well prior to 1849 when the Gold Rush began; however, the runs probably declined rapidly thereafter (Yoshiyama and others 1996, 1998). The California Fish Commission stated in 1886 (*in* Yoshiyama and others 1996): "The Tuolumne, a branch of the San Joaquin, at one time was one of the best salmon streams in the State. Salmon have not ascended the stream for some years". A U.S. Army officer in the San Joaquin basin wrote in the 1860s that he expected a poor salmon run in the San Joaquin River and its tributaries as a result of low flows and sedimentation from hydraulic mining (Mesick, personal communication, see "Notes"). Clark similarly reported in 1929 that "[t]he abundance of salmon in the Stanislaus is about the same as in the Tuolumne" and "that salmon in the Tuolumne are scarce". He further reported that "[t]he spring run amounts to almost nothing, but there are some fish that come up the stream in the fall."

It is likely that hydraulic mining caused the initial decline of the salmon and steelhead runs in the Stanislaus River, because the early dams were too small to substantially affect streamflows and they did not completely block the salmon's upstream migration until the original Melones Dam was constructed in 1926. The earliest "permanent" dam on the river, which was the original Tulloch Dam constructed in 1858, was a relatively low structure that had an opening at one end (Yoshiyama and others 1996). Miwok residents caught salmon upstream of the original Tulloch Dam at Burns Ferry Bridge and Camp Nine between 1870 and 1920 (Yoshiyama and others 1996) and so the construction of dams alone cannot account for the initial declines. On the other hand, hydraulic mining, which occurred in California between 1853 and 1884, is evident near Columbia and to a small degree near Knights Ferry in the Stanislaus River watershed (Figure 1).

Life History and Population Trends

Fall-run Chinook Salmon

Fall-run Chinook salmon have a complex life history (review by Healey 1991). They spend most of their lives in the ocean until they reach sexual maturity, then they stop feeding and return to their natal rivers to spawn. They locate their natal river primarily using olfactory cues that distinguish the Stanislaus River from other Central Valley rivers. Successful "homing" rates for adult hatchery Chinook salmon range between 84% and 99%; whereas fish that "stray" tend to enter other rivers with relatively high rates of flow (review by Mesick 2001). Adult fall-run Chinook salmon probably begin entering the Stanislaus River between late October and early November; fish observed in September and early October are probably spring-run Chinook salmon but tests have not been conducted to confirm this. The adult fall-run begins spawning shortly after they reach their spawning beds and spawning activity continues through late December. The female salmon constructs one or more nests, which are called redds, in gravel beds between Goodwin Dam and Riverbank (Figure 1). The female constructs the redds using her tail to dig several approximately 12-inch diameter and 12-inch deep egg pockets in the streambed. While she deposits about one thousand eggs in each egg pocket, one or more males fertilize the eggs. The female then buries with eggs in gravel that she moves from the streambed immediately upstream of the egg pocket. After she has dug several small pits in sequence and deposited a total of 4,000 to 9,000 eggs (CDFG 1990), there is a mound of gravel, abut 12 inches deep and 6 to 10 feet wide, called a tailspill that covers the egg pockets. Upstream of the tailspill, there is a shallow depression where the female obtained the gravel to bury the eggs. During the process of constructing the redd, the female washes most of the sand and silt from the gravel in the tailspill, thereby ensuring that initially, there is an adequate flow of oxygenated water over the eggs. The female will guard her redd from other spawning females and predators for 7 to 14 days until she dies. The eggs incubate in the gravel for about 45 days at a temperature of about 52^{o}F, which is typical for the Stanislaus River during their spawning period. After the eggs hatch, the larvae, which are called alevins, remain in the gravel for another 45 days where they begin feeding on plankton. The juvenile fall-run salmon typically emerge from the gravel between December and March in the Stanislaus River after absorbing most of their yolk sac; these fish are 30 to 40 mm in length and are called "fry" by fishery biologists. Most juvenile salmon produced in the Stanislaus River immediately migrate downstream to the Delta where they grow for several months feeding on plankton and small aquatic invertebrates before completing their migration to the ocean. However, some juveniles remain in the Stanislaus River for several months and up to a year before they begin their downstream migration to the ocean. Before they enter the ocean, the juveniles undergo a physiological transformation, called smoltification, which enables them to tolerate saltwater. Larger juveniles that migrate before they begin this transformation are called "parr" and are usually 40 to 80 mm in length. Other juveniles that begin this transformation when they migrate downstream, as evidenced by a silvery appearance, are called "smolts" and are usually 80 to 135 mm in length. A few juveniles remain in the Stanislaus River for about 12 months before migrating downstream toward the ocean; they are called yearlings and are typically about 150 mm in length when they migrate. After the juveniles reach the ocean, they typically remain near the coast and grow rapidly for at least 18 months (an Age 2 fish) before returning to spawn. Historically, some fall-run Chinook salmon remained in the ocean until Age 6, whereas in recent years most return to Central Valley rivers as Age 3 fish. Fishery biologists theorize that by migrating to and from the ocean at a variety of ages, Chinook salmon maximize their chances for survival. Their behavior ensures that although some fish from each brood will encounter natural environmental catastrophes, such as floods or droughts, other fish that delay their migration are likely to encounter conditions that favor their survival.

The CDFG began estimating the number of fall-run Chinook salmon that returned to spawn each year in the Stanislaus River in 1947 (Fry 1961), after their habitat had already been severely degraded by dredging and hydraulic mining. From 1951 to 2002, the number of two-year-old and older fall-run salmon that returned to spawn, which is referred to as escapement by fishery biologists, has averaged 5,263 for the lower Stanislaus River. CDFG's estimates of escapement to the Stanislaus River have ranged from 50 fish in 1978 to 35,000 fish in 1953. Between 1989 and 1996, escapement declined to consistently low levels, averaging only 642 fish per year.

However, it rebounded to an average of 5,884 fish per year between 1997 and 2002.

The fall-run Chinook population of the Stanislaus River is self-sustaining with only intermittent releases of hatchery-reared juvenile fish from the Merced River Fish Facilities that are used to study their survival as they migrate through the river. Between about 45,000 and 225,000 juvenile hatchery fish have been released annually in the lower Stanislaus River during 1986, 1988, 1989, 1999 and 2000. Another release of 125,000 fish was made in spring 2003.

Spring-run Chinook Salmon

The life history of spring-run Chinook salmon is similar to that of fall-run with a few exceptions. The primary difference is that adult Central Valley spring-run return to their natal rivers between mid-February and July and then they hold on the bottom of deep pools ($\geq$ 8 feet deep) in the upper watershed until September and October when they begin spawning (CDFG 1998a). By migrating during the spring when natural streamflows are highest, it is thought that spring-run could ascend past waterfalls up to about 10 feet in height into the upper watersheds. In contrast, adult fall-run may have been confined to the valley floor because some of the waterfalls in Goodwin Canyon may not have been passable at the low streamflows present during their fall migration period. Another difference between spring-run and fall-run is that spring-run spawn before fall-run and so the spring-run juveniles mature and begin their migrations shortly before the fall-run juveniles begin their migrations. Both the spawning and juvenile migration periods overlap for spring-run and fall-run Chinook salmon and it is not possible to distinguish one from another based on timing of spawning or juvenile migration alone.

Spring-run are thought to have been extirpated from the Stanislaus River after the construction of Melones Dam in 1926 blocked access to their habitat in the upper watershed. As a result, the Department of Fish and Game does not conduct surveys to determine whether spring-run are present in the Stanislaus River. However, there have consistent reports from recreational users of the river that a few adult salmon are present during most summers. The Fisheries Foundation (2002) has observed up to seven adult salmon between June and August 2000 at their study sites between Goodwin Dam and Oakdale. One location where U.S. Army Corps of Engineers grounds keepers have routinely observed them in the last several years is a deep gravel pit at the U.S. Army Corps of Engineers' Buttonbush Park (Figure 1). Although it is highly likely that these fish are adult spring-run Chinook salmon, they may be strays from the Sacramento River Basin. In summer 2000, CDFG used gill nets to capture 22 of these fish at Buttonbush and determined that three had coded-wire tags identifying them as strays from the Feather River Hatchery (Fisheries Foundation 2002). Since not all spring-run hatchery fish are identified with tags, it is possible that most or all are spring-run hatchery fish that strayed from the Sacramento River basin. A genetic analysis is needed to determine whether the spring-run are truly hatchery strays from the Sacramento River basin.

Steelhead

Steelhead are the anadromous form of rainbow trout that spend a portion of their life growing in the ocean and spawning in freshwater rivers (review by McEwan 2001). Historically, Central Valley steelhead were probably stream maturing in that the adults returned to their natal freshwater river with immature gonads during the spring high flow period and then spent several months holding in pools and feeding until they were ready to spawn. However, McEwan (2001) reports that the stream maturing ecotype is now extinct in the Central Valley and only an ocean maturing ecotype remains. The ocean maturing fish spend one to three years in the ocean (Behnke 1992) and spawn relatively soon after they enter freshwater primarily between January and March. Some fish, which are called "half-pounders", spend only their first summer and fall in the ocean or Delta and then return to their natal river as sexually immature fish during the following winter (Moyle 2002). Unlike Chinook salmon, 10-20% of adult steelhead survive after spawning and some return to spawn up to four times (Behnke 1992, Moyle 2002). After spawning, adult steelhead may hold in pools and feed before returning to the ocean. The eggs hatch in 3 to 4 weeks at 50 to 59^{o}F and the fry emerge from the gravel 2 to 3 weeks later (Moyle 2002). Approximately 70% of juvenile Central Valley steelhead remain in freshwater for two years before emigrating to the ocean, whereas 29% emigrate after one year and 1% emigrate after three years (McEwan 2001). Juveniles migrate downstream during most months of the year, but the peak period of emigration occurs in spring with a much smaller peak in fall (McEwan 2001).

Some steelhead and rainbow trout populations in the Central Valley are polymorphic, such that steelhead can give rise to rainbow trout and rainbow trout can give rise to steelhead trout (McEwan 2001). Microchemical analysis of the Sr:Ca ratios in otoliths extracted from three *O. mykiss* from the Calaveras River indicated that one steelhead was the progeny of a steelhead female; a non-anadromous male trout (that may have migrated to the estuary) was the progeny of a steelhead female; and another non-anadromous male trout was the progeny of a non-anadromous female trout (McEwan 2001). It is likely that the steelhead population in the Stanislaus River is polymorphic as well.

Large *O. mykiss* weighing a kilogram (2.2 pounds) or more are caught by anglers in the Stanislaus River primarily between January and April, and it is likely that some of these fish are anadromous steelhead whereas others are probably resident rainbow trout. Although the anadromous nature of the large trout has not been confirmed by extensive studies of strontium concentrations in otoliths or ocean growth patterns in scales, there are several characteristics of these fish that make it likely that many are steelhead:

- Scales taken from trout larger than 20 inches in length indicate a period of accelerated growth that is typical of estuary or ocean residence (McEwan 2001).
- Large adult fish weighing up to about 5.6 kilograms (12.25 pounds) are primarily caught from December through early June (Photo 1; Walser, personal communication, see "Notes"), which is the typical period that adult ocean-maturing steelhead migrate into Central Valley tributaries to spawn (McEwan 2001).
- Some of the 12-inch and larger fish have a bright silvery body and red color on their operculum, which is typical of steelhead that have just entered fresh water (Walser, personal communication, see "Notes").
- Some of the 12-inch and larger adults have lice, which may be a species found in the Delta (Bill Mitchell, personal communication, see Notes), that suggests that the fish either reside or migrate through the Delta.
- About 45% and 70% of the juvenile trout caught with screw traps from 1995 to 2002 at Oakdale and Caswell State Park, respectively, have characteristics typical of steelhead smolts migrating to the ocean: they are approximately 200 mm in length, have a smolt

index of 5 based on the IEP Steelhead Project Work Team Steelhead Life-stage Assessment Protocol (Photo 2; SPCA unpublished data).

- A genetic analysis of steelhead smolts captured in rotary screw traps on the Stanislaus River indicate that they are closely related to the upper Sacramento River steelhead, but not steelhead from the Mokelumne River Hatchery or Nimbus Hatchery on the American River (McEwan 2001) and so they appear to be a population of naturally produced fish. No hatchery reared steelhead are released in the San Joaquin River basin.

Photo 1. Steve Walser with a male O. mykiss near Lovers Leap on the lower Stanislaus River in spring 2002 (Photo provided by CRRF)

Although the abundance of adult steelhead is not surveyed in the Stanislaus River, the catch of adult steelhead by professional fishing guides (Walser, personal communication, see "Notes") using hook-and-line began to increase in 1997, when many fish between 12 and 15 inches were caught. Their catch increased again in 1999, when both the number and size (2 to 10 pounds) of the fish caught increased, and has remained high through 2002. The trend in the steelhead catch appears to provide a reasonable index of the trends in steelhead escapement. An increase in the abundance of adult fish in 1997 would be expected to result in an increase in the number of juveniles migrating two years later. Indeed, the number of spawning steelhead probably increased in 1997 because the number of juvenile steelhead caught in the Stanislaus River screw traps substantially increased in 1999 (Figure 2).

Photo 2. Stanislaus River Steelhead Smolt (Photo provided by SPCA)

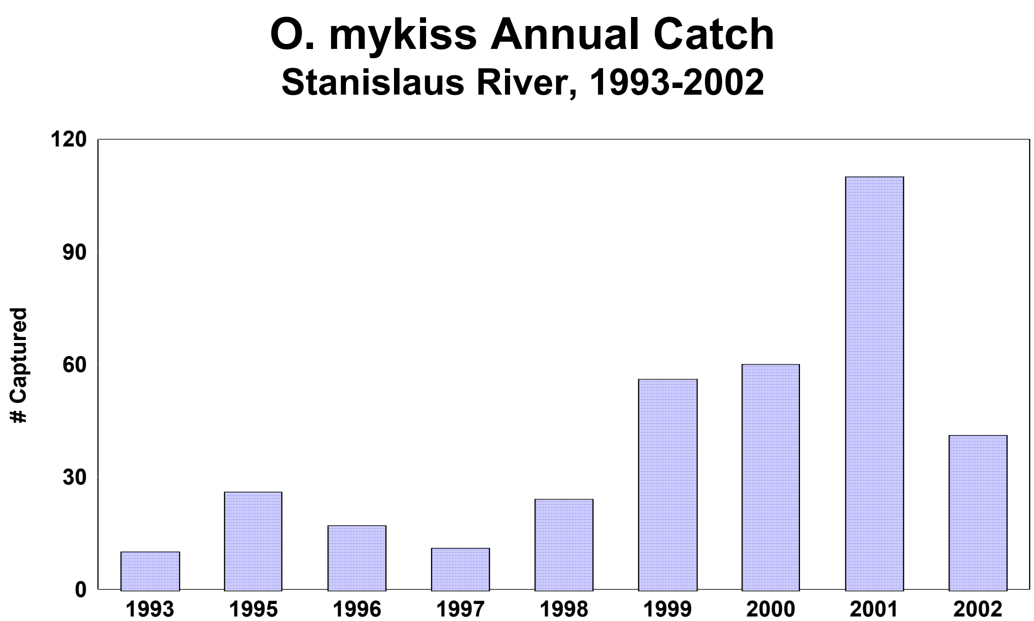

Figure 2. The total number of *O. mykiss* caught in screw traps at Oakdale and Caswell State Park in the lower Stanislaus River from 1993 to 2002 (SPCA unpublished data).

2 PUBLIC OUTREACH

2.1 PURPOSE OF THE PUBLIC OUTREACH PLAN

The initial outreach will be conducted by a professional facilitator and the planning team to inform the public, affected parties, and other stakeholders about the restoration plan, its ongoing status, and to provide the opportunity for input to the development of the plan.

2.2 TARGET AUDIENCE

The primary target audience for outreach will include all residents and recreational users of the lower Stanislaus River between Goodwin Dam and the confluence with the San Joaquin River, local government agencies, non-profit environmental and recreational organizations, and the local irrigation and water districts that obtain water from the Stanislaus River.

2.3 METHODS

A variety of tools, including meetings, newspaper announcements, Internet websites, and newsletters, will be used to conduct outreach throughout the development of the plan. In addition to the regular meetings of the Stanislaus River Fish Group and posting the restoration plan on the Internet, public meetings will be held at Knights Ferry and Oakdale to discuss the development of the restoration plan and to provide contact information. Notices of upcoming public meetings, contact information, and background information on the restoration plan will be published in the local newspapers (Oakdale Leader, Modesto Bee, and The Record), Internet message boards of California-based sport fishing groups, newsletters of participating organizations/agencies, and on web pages of the California Rivers Restoration Fund, S.P. Cramer and Associates, Inc., and the AFRP. The California Rivers Restoration Fund will link its website (www.calriversfund.org) with other non-profit organizations, such as California Trout, whereas S.P. Cramer and Associates, Inc., (www.stanislausriver.com) and Stanislaus River Fish Group have linked their websites with those of other resource agencies, such as the CALFED Bay-Delta Authority, Department of Water and Power, and Department of Fish and Game. The Stanislaus River Fish Group page can be found at http://www.delta.dfg.ca.gov/srfg/index.asp.

2.4 SUMMARY OF COMMENTS

This section will present a summary of all outreach related comments received on the restoration plan and responses to the comments.

3 EXISTING CONDITIONS OF THE LOWER STANISLAUS RIVER

3.1 OVERVIEW

The lower Stanislaus River has been extensively developed to provide water, hydroelectric power, gravel, agricultural, and residential uses. Developments in the lower San Joaquin River and Delta that may affect anadromous fish as they migrate between the Stanislaus River and the ocean are also briefly discussed.

3.2 WATER AND HYDROELECTRIC PROJECTS

The 32 dams within the Stanislaus basin large enough to be regulated by the Division of Safety of Dams have a total capacity of 2,846,500 acre-feet or 237% of the average unimpaired runoff. New Melones dam, which was completed in 1979 and approved for filling in 1981, has a storage capacity of 2,400,000 acre-feet and was designed to control floods up to the 100-year-flood (Kondolf and others 2001).

The operating criteria for New Melones Reservoir are governed by water rights, instream fish and wildlife flow requirements (including AFRP objectives), Bay-Delta flow requirements, dissolved oxygen requirements, Vernalis water quality, CVP contracts, and flood control considerations. Water released from New Melones Dam and Powerplant is re-regulated at Tulloch Reservoir, and is either diverted at Goodwin Dam or released from Goodwin Dam to the lower Stanislaus River.

Flows in the lower Stanislaus River serve multiple purposes. These include provision of water for riparian water rights, instream fishery flow objectives, water temperature, and instream dissolved oxygen (DO). In addition, water from the Stanislaus River enters the San Joaquin River, where it contributes to flow and helps improve water quality conditions at Vernalis. State Water Resources Control Board Decision (D)-1422, issued in 1973, provided the primary operational criteria for New Melones Reservoir and permitted USBR to appropriate water from the Stanislaus River for irrigation, municipal, and industrial uses. D-1422 requires that the operation of New Melones Reservoir include releases for existing water rights, fish and wildlife enhancement, and the maintenance of water quality conditions on the Stanislaus and San Joaquin rivers.

3.2.1 New Melones Interim Plan of Operation

Proposed CVP operations on the Stanislaus River are derived from the New Melones Interim Plan of Operation (NMIPO). The NMIPO was developed as a joint effort between USBR and USFWS, in conjunction with the Stanislaus River Basin Stakeholders (SRBS). The process of developing the plan began in 1995 with a goal to develop a long-term management plan with clear operating criteria. In 1996, the focus shifted to development of interim operations plans for 1997 and 1998. At a SRBS meeting on January 29, 1997, a final interim plan of operation was agreed to in concept. The NMIPO was transmitted to the SRBS on May 1, 1997. Although meant to be a short-term plan, it continues in effect. In summary, the NMIPO defines categories of water supply based on storage and projected inflow. It then allocates annual water release for fishery, water quality, Bay-Delta, and use by CVP contractors (Tables 1 and 2).

Table 1 Inflow characterization for the New Melones Interim Plan of Operation

Annual water supply category	*March-September forecasted inflow plus end of February storage (thousand acre-feet)*
Low	0 - 1400
Medium-low	1400 - 2000
Medium	2000 - 2500
Medium-high	2500 - 3000
High	3000 - 6000

Table 2 New Melones Interim Plan of Operation flow objectives (in thousand acre-feet)

Storage plus inflow		*Fishery*		*Vernalis water quality*		*Bay-Delta*		*CVP contractors*	
From	*To*	*From*	*To*	*From*	*To*	*From*	*To*	*From*	*To*
1400	2000	98	125	70	80	0	0	0	0
2000	2500	125	345	80	175	0	0	0	59
2500	3000	345	467	175	250	75	75	90	90
3000	6000	467	467	250	250	75	75	90	90

3.2.2 Water Rights Obligations

When USBR began operations of New Melones Reservoir in 1980, the obligations for releases to meet downstream water rights were defined in a 1972 Agreement and Stipulation among USBR, Oakdale Irrigation District (OID), and South San Joaquin Irrigation District (SSJID). The 1972 Agreement and Stipulation required that USBR release annual inflows to New Melones Reservoir of up to 654,000 acre-feet per year for diversion at Goodwin Dam by OID and SSJID, in recognition of their water rights. Actual historical diversions prior to 1972 varied considerably depending upon hydrologic conditions. In addition to releases for diversion by OID and SSJID, water is released from New Melones Reservoir to satisfy riparian water rights for agricultural irrigation totaling approximately 48,000 acre-feet annually downstream of Goodwin Dam.

In 1988, following a year of low inflow to New Melones Reservoir, the Agreement and Stipulation among USBR, OID, and SSJID was superseded by an agreement that provided for conservation storage by OID and SSJID. The new agreement required USBR to release New Melones Reservoir inflows of up to 600,000 acre-feet each year for diversion at Goodwin Dam by OID and SSJID. In years when annual inflows to New Melones Reservoir are less than 600,000 acre-feet, USBR provides all inflows plus one-third the difference between the inflow for that year and 600,000 acre-feet per year. The 1988 Agreement and Stipulation created a conservation account in which the difference between the entitled quantity and the actual quantity diverted by OID and SSJID in a year may be stored in New Melones Reservoir for use in subsequent years.

Tri-Dam Project and Stockton East Water District Reservoirs

The Tri-Dam project is a partnership between the Oakdale Irrigation District (OID) and the South San Joaquin Irrigation District (SSJID) that was formed in 1948. Tri-Dam was formed to develop, operate and maintain the Beardsley/Donnells project on the middle fork of the Stanislaus River and the Tulloch project downstream of New Melones Reservoir for water storage and power generation. The Beardsley/Donnells project can store about 160,000 acre-feet of water and the Tulloch Project can store about 67,000 acre-feet of water. OID, SSJID, and the Stockton East Water District (SEWD) also own Goodwin Dam, which is just downstream of Tulloch. Goodwin, which can store up to 500 acre-feet of water, is the point of diversion for water for all three districts. It has no hydropower generating facilities. OID and SSJID also obtain water by recapturing drainage water and pumping from deep wells. The water is currently used to irrigate about 144,000 acres of land within the Districts. The irrigated land supports almonds, peaches, apples, walnuts and other crops.

The Beardsley/Donnells and Tulloch projects combined produce about 533,000,000 kwh of power annually. The Tulloch Powerhouse is operated primarily as a run-of-river operation and the Tulloch Reservoir also serves as an afterbay for the New Melones Powerhouse. OID and SSJID also own and operate the Sand Bar Project, which is purely a hydroelectric project located downstream of the Beardsley Afterbay Dam; it generates about 73,000,000 kwh annually. The power is sold to PG&E with the revenues used to: 1) pay off the bonds used to finance the projects; 2) maintain the power project facilities; 3) maintain and improve the water delivery system; and 4) offset the increasing cost of water for their customers.

3.2.3 Instream Flow Requirements

Under D-1422, USBR is required to release up to 98,000 acre-feet of water per year from New Melones Reservoir to the Stanislaus River on a distribution pattern to be specified each year by CDFG for fish and wildlife purposes. In 1987, an agreement between USBR and CDFG provided for increased releases from New Melones to enhance fishery resources for an interim period, during which habitat requirements were to be better defined and a study of Chinook salmon fisheries on the Stanislaus River would be completed. During the study period, releases for instream flows would range from 98,300 to 302,100 acre-feet per year. The exact quantity to be released each year was to be determined based on storage, projected inflows, projected water supply and water quality demands, and target carryover storage. Because of dry hydrologic conditions in the 1987 to 1992 drought period, the ability to provide increased releases was limited. USFWS published the results of a 1993 study, which recommended a minimum instream flow on the Stanislaus River of 155,705 acre-feet per year for spawning and rearing of fall-run Chinook salmon (Aceituno 1993).

3.2.4 Anadromous Fish Restoration Plan Flows

AFRP flow volumes on the Stanislaus River, as part of the NMIPO, are based on the New Melones end-of-February storage plus forecasted March to September inflow as shown in the NMIPO (Tables 3.2.1-1 and 3.2.1-2). The AFRP volume is then initially distributed based on modeled AFRP distributions and patterns used in the NMIPO. Actual flows below Goodwin Dam will be determined in accordance with Attachment 2 of the Department of the Interior Decision on Implementation of Section 3406 (b)(2) of the Central Valley Project Improvement Act October 5, 1999.

3.2.5 Bay-Delta Vernalis Flow Requirements

D-1641 sets San Joaquin River at Vernalis flow requirements from February to June. These flows are commonly known as San Joaquin River base flows. USBR has committed to provide these flows during the interim period of the Bay-Delta Accord. The NMIPO describes the commitment USBR has made regarding the operation of New Melones Reservoir. If the NMIPO does not commit resources to this objective and the objective is at risk of non-compliance, USBR will pursue other strategies (for example, water purchases) to meet the base flow commitment.

3.2.6 Dissolved Oxygen Requirements

D-1422 requires that water be released from New Melones Reservoir to maintain DO standards in the Stanislaus River. The 1995 revision to the Water Quality Control Plan (WQCP) established a minimum DO concentration of 7 milligrams per liter (mg/l), as measured on the Stanislaus River near Ripon.

3.2.7 Vernalis Water Quality Requirement

D-1422 also specifies that New Melones Reservoir be operated to maintain an average monthly level of conductivity, commonly measured as total dissolved solids (TDS), on the San Joaquin River at Vernalis as it enters the Delta. D-1422 specifies an average monthly concentration of 500 parts per million (ppm) TDS for all months. Historically, releases have been made from New Melones Reservoir for this standard, but due to shortfalls in water supply, USBR has not always been successful in meeting this objective. In the past, when sufficient supplies were not available to meet the water quality standards for the entire year, the emphasis for use of the available water was during the irrigation season, generally from April through September. D-1641 modified the water quality objectives at Vernalis to include the irrigation and non-irrigation season objectives contained in the 1995 Bay-Delta WQCP. The revised standard is an average monthly conductivity 0.7 microSiemens per centimeter (approximately 455 ppm TDS) during the months of April through August, and 1 mS/cm (approximately 650 ppm TDS) during the months of September through March.

3.2.8 Hydropower Operations

New Melones Powerplant operations began in 1979. The powerhouse is rated at 300 Megawatts. Power generation occurs when reservoir storage is above the minimum power pool of 300,000 acre-feet. When possible, reservoir levels are maintained to provide maximum energy generation.

3.2.9 Flood Control

New Melones Reservoir flood control operation is coordinated with the operation of Tulloch Reservoir. The flood control objective is to maintain flood flows at the Orange Blossom Bridge at less than 8,000 cubic-feet-per-second (cfs). When possible, however, releases from Tulloch Dam are maintained at levels that would not result in downstream flows in excess of 1,250 cfs to 1,500 cfs because of potential damage to permanent crops in the floodplain that may occur at flows above this level. Up to 450,000 acre-feet (~19%) of the 2.4 million acre-foot storage volume in New Melones Reservoir is dedicated for flood control and 10,000 acre-feet of Tulloch Reservoir storage is set aside for flood control. Based upon the flood control diagrams prepared by USACE, part or all of the dedicated flood control storage may be used for conservation storage, depending on the time of year and the current flood hazard.

3.2.10 CVP Contracts

USBR has entered into water service contracts for the delivery of water from New Melones Reservoir, based on a 1980 hydrologic evaluation of the long-term availability of water in the Stanislaus River Basin. Based on this study, USBR entered into a long-term water service contract for up to 49,000 acre-feet per year of water annually (based on a firm water supply), and two long-term water service contracts totaling 106,000 acre-feet per year (based on an interim water supply). Because diversion facilities were not yet fully operational and water supplies were not available during the 1987 to 1992 drought, no water was made available from the Stanislaus River for delivery to CVP contractors prior to 1992.

3.2.11 San Joaquin River Agreement

Adopted by the SWRCB in Water Rights Decision 1641 on 29 December 1999 (revised on 15 March 2000 in accordance with Order WR 2000-02), the San Joaquin River Agreement (SJRA) includes a 12-year experimental program providing for flows and exports in the lower San Joaquin River during a 31-day pulse flow period during April-May. It also provides for the collection of experimental data during that time to further the understanding of the effects of flows, exports, and the barrier at the head of Old River on salmon survival. This experimental program is commonly referred to as the Vernalis Adaptive Management Program (VAMP).

An Environmental Impact Statement/Environmental Impact Report (EIS/EIR) is prepared annually for the water acquisition (flow) portion of the SJRA. Within the SJRA, the NMIPO has been assumed to form part of the basis for which flows will be provided on the San Joaquin River to meet the target flows for the 31-day pulse during April-May. Additional flows to meet the targets will be provided from other sources in the San Joaquin River under the control of the parties to the SJRA.

The operations forecasts include Vernalis flows that meet the appropriate pulse flow targets for the assumed hydrologic conditions. The flows in the San Joaquin River upstream of the Stanislaus River are forecasted for the assumed hydrologic conditions. These flows are then adjusted so that when combined with the forecasted Stanislaus River flow based on the NMIPO, they provide the appropriate Vernalis flows consistent with the pulse flow target identified in the SJRA. An analysis of how the flows are produced upstream of the Stanislaus River is included in the SJRA EIS/EIR.

3.2.12 Release Temperatures From New Melones Dam

The presence of Old Melones Dam within New Melones Reservoir causes the release of warm surface water from New Melones Reservoir whenever storage levels fall below about one million acre-feet, a problem that occurred in 1991 and 1992 (Loudermilk 1996). In addition, Tulloch Reservoir can be warmer than 56 ^{o}F through the end of October although cold water releases are made from New Melones (CDFG 1998b). A new water temperature model is currently being developed to compare alternatives for improving water temperatures for salmonids in the lower Stanislaus River.

3.3 GEOMORPHIC PROCESSES AND GRAVEL MINING

3.3.1 Historical Flows

The US Geological Survey (USGS) gage (# 11302500) records at Oakdale between 1895 and 1899 provide the best available representation of flows prior to the construction of reservoirs in the watershed (Kondolf and others 2001). During 1896, 1897, and 1899, the hydrograph can be characterized by (1) flashy winter storms that increased flows up to 14,000 cfs in January and February; (2) snowmelt that provided consistently high flows between 2,000 and 13,000 cfs from March to June, (3) small runoff events between late-September and December, and (4) minimum base flows of 50 to 180 cfs from mid-July through October (Appendix 1). During 1898, which was the driest year between 1895 and 1899, snowmelt flows ranged between 500 to 4,000 cfs flows and the minimum base flow was 27 cfs (Appendix 1).

During the pre-reservoir period, the prolonged period of high flows from snowmelt between March and June corresponds exactly with the time when most adult spring-run Chinook salmon (CDFG 1998a) and adult stream-maturing (summer-run) steelhead (McEwan 2001) migrated upstream to holding habitat in the upper watershed. Adult ocean-maturing (winter-run) steelhead would have migrated upstream to spawn in the mid- to lower basin during the flashy fall and winter storms (McEwan 2001). Adult fall-run Chinook salmon probably began their upstream migration in response to small storm events that produced runoff of 50 to 760 cfs between 1895 and 1899 in late-September and October. The runoff from these small storms probably was an important cue for the adult salmon because it provides the scent of their natal stream, which they rely on for navigation once they enter the Delta (Mesick 2001). Most of the juvenile salmon probably migrated downstream during the high flows during either the winter storms as fry or during the spring snowmelt period as smolts. Most juvenile steelhead would have reared in the Stanislaus River for two years before migrating downstream as 200-mm long smolts during the spring snowmelt period (see Section 1.2.2).

3.3.2 Bed Mobility Flow Estimates

Kondolf and others (2001) conducted a crude bed mobility flow evaluation at five Knights Ferry

Gravel Replenishment sites between Goodwin Dam and Oakdale where gravel had been added in late summer 1999. They estimated that flows around 5,000 to 8,000 cfs are necessary to mobilize the median size of the gravel (D_{50}) placed at these sites. They also concluded that higher flows would be needed to mobilize bars to prevent further encroachment of riparian vegetation in the active channel. Before construction of New Melones Dam, a bed mobilizing flow of 5,000 to 8,000 cfs was equivalent to a 1.5 to 1.8 year return interval flow. After the construction of New Melones Dam, 5,000 cfs is approximately a 5-year flow and 8,000 cfs exceeds all flows within the twenty-one year study period between 1979 and 2000.

3.3.3 Sediment Budget

Kondolf and others (2001) roughly estimate that a minimum of 1,031,800 cubic-yards of gravel were extracted from the active channel and an additional 5,292,500 cubic-yards of gravel were extracted from the floodplain between Goodwin Dam and Oakdale from 1939 to 1999 based on a reconnaissance-level assessment. The total amount of gravel extracted is estimated to be 600% of the amount naturally supplied from the watershed between 1939 and 1999, which is about 1,033,900 cubic-yards. The amount of sand and gravel produced in the unregulated tributaries below Goodwin Dam was estimated to about 84,700 cubic-yards from 1939 to 1999, which is almost two orders of magnitude smaller than the volume extracted. Furthermore, the tributaries below Goodwin dam probably produce a small amount of gravel-sized sediment (Kondolf and others 2001). Kondolf and others (2001) estimated that if mining were to cease today and the natural annual sediment supply was restored, it would take 300 to 400 years to make up for the losses from extraction over the last 50 years.

3.3.4 Geomorphic Changes Due to New Melones Dam

A study of aerial photographs and field observation by Kondolf et al (2001) indicate that the Stanislaus River has changed from a dynamic river system, characterized by depositional and scour features, to a relatively static and entrenched system. Changes since the construction of New Melones Dam include: (1) large scale vegetation encroachment in the active channel, primarily by willow and blackberry; (2) reduced reproduction of cottonwoods; and (3) substantial encroachment by urban and agricultural development, particularly orchards, in floodplain areas, thereby altering the natural river channel-floodplain connection. Kondolf and others (2001) also speculate that the dam reduced channel diversity through loss of alternating bar sequences and that the active channel has become incised. A comparison of field measurements between 1996 and 1999 suggest that the channel widened from 2.3 to 13.4 feet at five different riffles between Two-Mile Bar and Oakdale during prolonged releases in 1997 and 1998 (Schneider 1999, Kondolf and others 2001). However, CMC (Appendix 2) speculates that the loss of alternating bar sequences and channel incision was primarily a result of gravel mining in the active channel prior to 1980 (see Section 3.3.5). CMC agrees with Kondolf and others (2001) that encroachment of the riparian vegetation and reduced gravel recruitment has led to the coarsening of the bed material, particularly within spawning habitat in the unmined reaches between Goodwin Dam and Honolulu Bar.

3.3.5 In-River Gravel Mining

Drag lines were used to dredge the gravel and the spawning habitat from several reaches of the active riverbed primarily during the 1940s until about 1970 (P. Frymire, personal communication, see "Notes"). The dredged channels are now either large instream pits or long, uniform ditches that provide almost no habitat for salmonids. CDFG maps of the spawning riffles in 1972 show the locations of dredger tailings and "old drag lines" adjacent to the mined reaches (Appendix 2). The following table presents the estimated amount of habitat that was mined in different reaches of the lower Stanislaus River based on an evaluation of the 1972 CDFG riffle maps and spawning surveys in 1994 and 1995 (Appendix 2).

Reach	Percentage Mined	Spawning Riffles/Mile in 1972
Upper Goodwin Canyon, Rivermile 58.5 to 56.0	0.04%	3.6
Knights Ferry, Rivermile 54.7 to 53.5	0.0%	7.5
Lovers Leap, Rivermile 53.5 to 51.6	97.0%	2.6
Below Willms Pond, Rivermile 51.6 to 51.1	0.0%	12.0
Horseshoe Road, Rivermile 51.1 to 49.75	97.5%	2.2
Honolulu Bar, Rivermile 49.75 to 48.5	0.0%	7.2
Above Orange Blossom, Rivermile 58.5 to 47.4	98.2%	0.9
Below Orange Blossom, Rivermile 47.4 to 44.9	0.0%	6.8
Total: 13.15 miles	39.3%	--

Small instream mine pits that occur in the primary salmonid spawning areas include one just upstream of Two-Mile Bar at rivermile 56.9, two adjacent pits near rivermile 53.5, Willm's Pond at rivermile 51.8, and the Button Bush Pond at rivermile 48.2. There is a large, approximately one-mile long pit at rivermile 39.4 that is called the Oakdale Recreation Pond. Captured mine pits trap bedload sediment, store large volumes of sand and silt, and pass sediment-starved water downstream where it typically erodes the channel bed and banks to regain its sediment load (Kondolf and others 2001). At the upstream and downstream ends of the pit, the over-steepened bed is an unstable knickpoint, which causes bed erosion such that the pit elongates in both an upstream and downstream direction. On the Stanislaus River, incision has been limited due to the reduction in channel forming flows since the construction of New Melones Dam.

Dredged channels and pits also reduce flow turbulence and thereby potentially reduce dissolved oxygen concentrations and provide habitat for fish that prey on juvenile salmonids. Reduced dissolved oxygen may contribute to mortality of juvenile and adult salmonids when water temperatures are unsuitably warm in late spring and early fall.

3.4 FLOODPLAIN CONVERSION FOR AGRICULTURAL USES

Typical riparian vegetation along the lower Stanislaus River consists of black cottonwood (*Populus trichocarpa*), California sycamore (*Platanus racemosa*), several species of willow (*Salix* spp.), alder (*Alanus* spp.) and oak (*Quercus* spp.), with an understory of California wild grape (*Vitis californica*), blackberry (*Rubus vitifolius*), elderberry (*Sambucus glauca*), and a variety of grasses (CDFG 1972). No analyses have been conducted to assess the amount of riparian habitat along the lower Stanislaus River that has been converted for agricultural use or commercial gravel mining. The Department of Fish and Game conducted analyses of aerial photographs taken in 1958 and 1965 that indicated that there were approximately 3,300 acres of riparian habitat between the Knights Ferry Bridge and the San Joaquin River in 1958, but only 2,550 acres in 1965 as a result of conversion for agricultural uses and commercial gravel mining (CDFG 1972). The amount of riparian habitat appears to have stabilized since 1965 based on a third analysis conducted by the U.S. Fish and Wildlife Service with 1994 aerial photos (USFWS 1995). The USFWS analysis indicates that there were approximately 2,590 acres of riparian and wetland habitat in this reach (see table below). They also estimated that there were approximately 4,155 acres of agricultural land, 725 acres of land disturbed primarily for commercial gravel mining, and 823 acres of land converted for urban use within a 1,500 foot wide corridor of riparian and upland habitats in this reach (USFWS 1995). Moreover, the presence of riparian habitat does not imply that connectivity exists between the floodplain and the active channel under the current flow regime; instead, groundwater may sustain some species of riparian vegetation without flooding. The USFWS study did not distinguish between riparian/floodplain habitat and upland habitat and so the amount of riparian habitat converted for agricultural and mining use cannot be estimated with this data. However, the USFWS habitat maps clearly indicate that much of the riparian habitat of the lower Stanislaus River has been converted into other uses (USFWS 1995).

Table 1. Area of each habitat type in a 1,500-ft wide corridor (750 feet from river's center line) along the Stanislaus River in a Foothill Reach between Knights Ferry and the Orange Blossom Bridge and a Valley Reach between the Orange Blossom Bridge and the confluence with the San Joaquin River that was measured for the Habitat Evaluation Procedure for the Stanislaus River Basin and Calaveras River Water Use Program (USFWS 1995)

Habitat Type	Foothill Reach (acres)		Valley Reach (acres)	
Riparian	326.17	24.0%	2,255.56	26.90%
Wetland	6.35	0.5%	1.08	0.01%
Riverine	77.36	5.7%	538.43	6.40%
Gray Pine-Oak Woodland	55.85	4.1%	1.40	0.02%
Grassland	282.46	20.7%	473.38	5.60%
Rockland	31.31	2.3%	0.00	0.00%
Agriculture	230.80	17.0%	3,924.19	46.80%
Disturbed	225.24	16.5%	500.46	6.00%
Urban	126.44	9.3%	696.19	8.30%
Total	1,361.98		8,390.69	

The Foothill Reach began at the covered bridge in Knights Ferry and ended at the Orange Blossom Bridge. The Valley Reach began at the Orange Blossom Bridge and ended at the confluence with the San Joaquin River.

3.5 INTRODUCED NUISANCE SPECIES

Introduced aquatic species that occur in the California Central Valley are listed below and described in Appendix 3. Some if not all of these species occur in the lower Stanislaus River and they are a problem because they can displace native species and thus deplete food resources used by salmonids. This may be particularly true of the Asian clam because they are present throughout the Stanislaus River below Knights Ferry and they are very abundant, up to almost 1,200 per square-foot in degraded gravel beds (CMC and others 1996). Giant Reed, Himalayan blackberry, and tree of heaven (*Ailanthus altissima*) are other introduced species that are relatively common in the riparian zone of the lower Stanislaus River. These species are capable of displacing native woody riparian species, such as Fremont cottonwood, arroyo willow, alder, and ash that may contribute organic material that is usable by native invertebrate species that provide food for salmonids. In addition, the native woody riparian species may help maintain the habitat complexity by providing instream woody debris when they die. Surveys for introduced species have not been done for the lower Stanislaus River and it is likely that other species are present.

- Brazilian Waterweed, *Egeria densa*
- Broadleaf Pepperweed, *Lepidium latifolium*
- Canadian Waterweed, *Elodea canadensis, E. nuttallii*
- Eurasian Watermilfoil, *Myriophyllum spicatum*
- Giant Arundo or Giant Reed, *Arundo donax*
- Hydrilla or Waterthyme, *Hydrilla verticillata*
- Ludwigia or Uraguayan Primrose-Willow, *Ludwigia grandiflora*
- Parrot Feather or Watermilfoil, *Myriophyllum aquaticum*
- Purple Loosestrife, *Lythrum salicaria*
- Scarlet Wisteria, *Sesbania punicea*
- Tamarisk or Saltcedar, *Tamarix spp.*
- Water Hyancinth, *Eichornia crassipes*
- Yellow Flag Iris, *Iris pseudacorus*
- Asian Clam (freshwater), *Corbicula fluminea*
- Chinese Mitten Crab, *Eriocheir sinensis*

3.6 DOWNSTREAM CONDITIONS

Although beyond the scope of this restoration plan, the survival of anadromous fish of the Stanislaus River is highly dependent on conditions in the mainstem San Joaquin River, San Joaquin Delta, San Francisco Bay estuary, and ocean. Consideration of the downstream conditions is important for several reasons:

1. Flow management and habitat restoration can affect whether juvenile salmonids rear in the lower Stanislaus River or migrate to the Delta to rear. If true, our actions should consider whether juveniles are more likely to successfully rear in the downstream areas or in the lower Stanislaus River**.**
2. Management of streamflow, agricultural return flows, and erosion in the Stanislaus River affect habitat conditions, juvenile survival, and adult migrations in the downstream areas.
3. If escapement is used to judge the success of our restoration and management activities, then the effects of downstream conditions on escapement must be considered.
4. Information on downstream conditions that are important to the health of the Stanislaus River salmonid populations can be compiled here for the use of resource agencies that manage the downstream areas.

3.6.1 Delta Reclamation and the Deep-Water Ship Channel

Prior to 1850, the Sacramento-San Joaquin Delta, an area of nearly 750,000 acres, was mostly a tidal marsh that consisted of a network of sloughs and channels during low flows and a large inland lake during flooding. The development of the Delta into farmland began in 1850 when the Swamp Land Act conveyed ownership of all swamp and marshes from the federal government to the State. Initial reclamation consisted of the construction of levees with peat soils on Rough and Ready Island and Roberts Island. These initial levees failed and in the 1870s steam-powered dredges were used to excavate alluvial soils to construct much larger levees. By the 1930s, reclamation was considered complete and the number of operating dredges declined greatly. However, due to continued subsidence of the peat soils, the Army Corps of Engineers continually adds material to maintain the levees, many of which range between 15 and 25 feet high.

The Port of Stockton and the deepwater ship channel in the San Joaquin Delta were completed in 1933. Activity at the Port of Stockton increased greatly in 1942 with the construction of military ships, mine sweepers, and landing craft. Shortly thereafter, large passenger cruise ships began navigating through the Delta. Currently the river is dredged to a depth of 35 feet to allow passage of deep draft ships; whereas upstream of the ship channel, depths range between 8 and 12 feet.

The Port of Stockton has recently contracted with the USACE to study the feasibility of deepening the deep-water ship channel between the port and Pittsburg (The Sacramento Bee, July 18, 2002). The first phase of the study will analyze the effects on water quality and the economics of deepening the 25-mile channel.

3.6.2 Water Quality in the Deep-Water Ship Channel

Dissolved oxygen (DO) concentrations are low in the deep-water ship channel during summer and early fall months partly (if not primarily) as a result of the decomposition of algal biomass that is produced in the comparatively shallow, nutrient-rich water upstream of Mossdale and subsequently transported into the much deeper waters of the ship channel (McCarty 1969; Van Nieuwenhuyse, personal communication). The algae, mostly diatoms, are not adapted to deep-water conditions and quickly settle out and decompose on the streambed. The ultimate biological oxygen demand (BOD), calculated as a function of flow, CBOD5, ammonia, algae, detritus, and phenophytin, was 3,600 to 3,900 kg/day for the Stockton load and 30,000 to 35,000 kg/day for the upstream river load (Chen and Tsai 2003). Based on their model, Chen and Tsai (2003) suggested that the sinks and sources of DO in the deep water ship channel are +1,500 kg/day for photosynthesis, -3,900 kg/day for algae respiration, -1,600 kg/day for nitrification, -1,800 kg/day for sediment oxygen demand, -3,000 kg/day for the decay of CBOD, Detritus, and pheophytin, and +2,300 kg/day for surface aeration. High water temperatures lower DO by (1) reducing the solubility of oxygen in water and (2) increasing the rate that oxygen in consumed by biological and chemical processes (CBOD). Schanz and Chen (1993) suggested that closing the head of Old River barrier and thereby increasing flow in the deep-water ship channel would improve DO conditions at Stockton during most months. However in October, warm temperatures and the DO demand exerted by ammonia from the Stockton wastewater plant, the rotting algal biomass, and other organic matter usually keep DO levels well below the 6 mg/l standard. Chen and Tsai (2003) suggest that if the deep-water ship channel is restored to its original depth of 8-10 feet, the DO deficit disappears at streamflows of 1,000 cfs.

Another means of controlling the oxygen deficit in the deep-water ship channel would be to require an EPA-style TMDL (total maximum daily load) limit for nutrients (especially phosphorus) in the San Joaquin catchment (Lee and Jones-Lee 2001). The chlorophyll levels at Vernalis are literally among the highest ever recorded for streams worldwide and much of this production may be fueled by feedlot operations and tile drainage from row crops or orchards.

The loading of dissociated ammonium from the Stockton wastewater facility and other sources may pose a potential toxicity problem. When algae are abundant and DO upstream becomes supersaturated (due to photosynthesis), pH levels also increase. High pH and high ammonium concentration lead to higher levels of undissociated ammonia, which is toxic to fish and aquatic invertebrates. It is possible that the salmon are responding to this toxicity as well as to low DO.

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NOTES

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Mesick, C.F. Poster at Indian Grinding Rock State Historic Park, 14881 Pine Grove-Volcano Road, Pine Grove, California. The poster was observed in 1995 but it has since been removed.

Van Nieuwenhuyse, E. U.S. Fish and Wildlife Service, Habitat Restoration Coordinator, Stockton California, August 1998. Currently with the U.S. Bureau of Reclamation, Sacramento, California.

Walser, S.B. Executive Director of California Rivers Restoration Fund and owner/professional fishing guide for Sierra West Adventures, Soulsbyville, California.